*EV/DV100 Series Power Meter*

# User's Manual

ACCUENERGY

*Your Power and Automation Partner*

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Please read this manual carefully before doing installation, operation and maintenance of This product. Following symbols are used in this user's manual and on meter to alert the dangerous or to prompt in the operating or set process.

Dangerous symbol, Failure to observe the information may result in injury or death.

Alert symbol, Alert the potential dangerous.
Observe the information after the symbol to avoid possible injury or death.

Dangerous

Near dangerous position, Failure to observe the information may result in injury or death.

Note Symbol, Observe it and avoid result in meter damage or human injury or death.

Instrument should be well grounded and power off before maintenance. Installation and maintenance of the meter should only be performed by qualified, competent personnel that have appropriate training and experience with high voltage and current device.

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# Chapter 1 Introduction



## 1.1 Description of EV/DV

***Powerful and Economical***

EV/DV series power meter is design for single phase electrical value measurement by using of latest microprocessor and digital signal process technology. It can True-RMS measure Voltage, Current, Power, Reactive Power, Power Factor, Frequency and Energy. The meter can be well used in high harmonic environment especially in middle and low voltage power system, electric apparatus, power system automation and factory automation. All the measuring electrical value is available via digital RS485 communication port running Modbus TM Protocol. The meter also got some I/O functions that made the metering, monitoring, remote controlling and Analog output in one unit.

***Small Size & Easy install***

EV/DV series was designed in compact size DIN96*48 and reduced depth 60mm. It suitable for small cabin install in switch gear. Easy install on panel by using clips.

***Easy to Use***

Large character LCD with blue back light made the display easy to read even under the dark light. All the Value reading and parameter setting can be access by using 4 panel keys or communication port. The parameters are protected in EEPROM, which will maintain its content after the meter is power off.

***High Reliability and Safety***

Multi-isolation and immunity methods were adopted in the EV/DV design according to the industry standards. The meter can be installed in hazard industry area. Also the meter was tested under IEC standards and EMC standards. The meter house was designed by using glass polymer which is durable and antifire.

## 1.2 Application Area

EV/DV series meter can be used to replace analog meter, panel meter, transducer and small RTU in power distribution or power automation system. As it adopted true-RMS measuring method, the EV/ DV series are competent for measuring voltage and current in high distortion nonlinear load system, such as VVVF, Electric Ballast, Computer etc.

Power Distribution Automation
Intelligent Electric Switch Gear
Industry Automation
Building Automation
Energy Manage System
Industry Apparatus

## 1.3 EV/DV Series

EV/DV series power meter is used mainly in single phase or balance three phase system.

EV series meter has measuring, communication and I/O functions. EV16x is single measuring function meter with communication port while EV18x and EV190 is multi-function meter with communication port. For detail please refer to Table1.1.

DV series meter has measuring and AO functions. DV10x is single measuring function meter while DV12X and DV130 are multi-function meters. For detail please refer to Table1.2.

| | Item | EV161 | EV162 | EV163 | EV164 | EV165 | EV166 | EV167 | EV182 | EV184 | EV188 | EV190 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Meter-ing | Voltage V | ● | | | | | | | ● | | ● | ● |
| | Current I | | ● | | | | | | ● | | ● | ● |
| | Power P | | | ● | | | | | | ● | ● | ● |
| | Reactive Power Q | | | | ● | | | | | ● | | ● |
| | Apparent Power S | | | | | | | | | | | ● |
| | Power Factor PF | | | | | ● | | | | ● | | ● |
| | Frequency Hz | | | | | | ● | | | | | ● |
| Energy | Energy Ep | | | | | | | ● | | | ● | ● |
| I/O Option | Digital Input DI | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| | Relay Output RO | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| AO Option | 4~20mA or 0~1m or 0~5V | □ | □ | □ | □ | □ | □ | | □ | □ | □ | □ |
| Com-muni-cation | RS485 Modbus Protocol | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

● Function □ Option Blank NA

Table1.1 EV100 Series Power Meter

| | Item | DV101 | DV102 | DV103 | DV104 | DV105 | DV106 | DV107 | DV122 | DV124 | DV128 | EV130 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Meter-ing | Voltage V | ● | | | | | | | ● | | ● | ● |
| | Current I | | ● | | | | | | ● | | ● | ● |
| | Power P | | | ● | | | | | | ● | ● | ● |
| | Reactive Power Q | | | | ● | | | | | ● | | ● |
| | Apparent Power S | | | | | | | | | | | ● |
| | Power Factor PF | | | | | ● | | | | ● | | ● |
| | Frequency Hz | | | | | | ● | | | | | ● |
| Energy | Energy Ep | | | | | | | ● | | | ● | ● |
| AO Option | 4~20mA or 0~1m or 0~5V | □ | □ | □ | □ | □ | □ | | □ | □ | □ | □ |

Table 1.2 DV100 Series Power Meter

# Chapter 2 Installation

## 2.1 Appearance and Dimensions

### *2.1.1 Appearance*

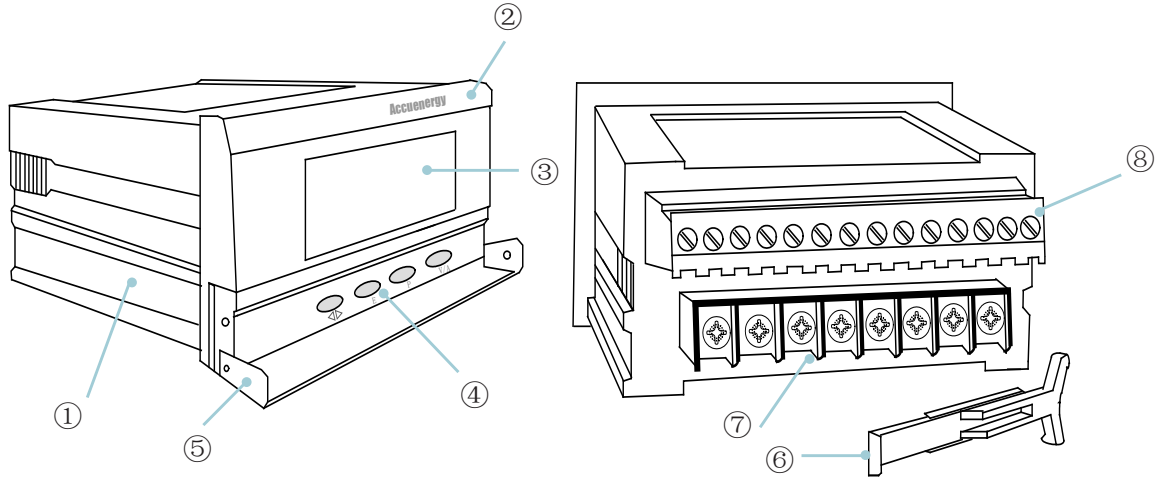



Fig 2.1 EV190 appearance

| Part Name | Description |
|---|---|
| ① House | Meter House is made of High Strength anti fire glass-polymer |
| ② Front Panel | Front Part of the Meter |
| ③ Display Window | LCD Display Window |
| ④ Key | Used to change display and setting the parameters |
| ⑤ Key Door | Used to protect key Mis-press |
| ⑥ Clip | Used fasten the meter on the panel |
| ⑦ Input Terminal | Power supply, Voltage and Current Input Terminal |
| ⑧ Auxiliary Terminal | Digital Input, Relay Output, Analog Output and Communication Terminal |

Table 2.1 Part Name of Meter

### 2.1.2 Dimension(mm)

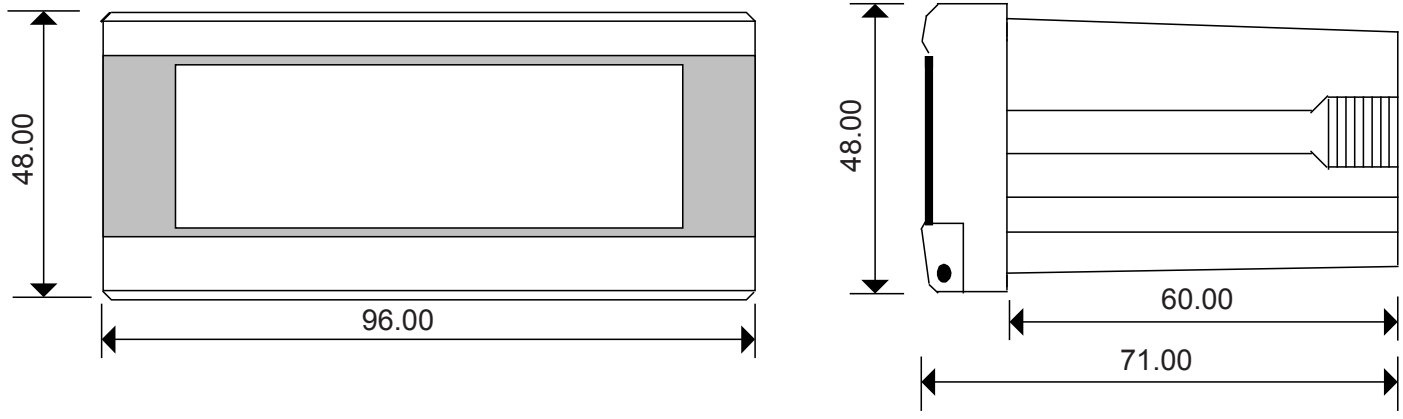



Fig 2.2 Dimension

## 2.2 Installation

**Note**

The environment temperature, humidity and position should be in the meter's specification range.

***Environment***

Before installation, please make sure that the environment should satisfy the following conditions.

1. Temperature

EV/DV meter's working temperature range are from -20℃ to 70℃. If the meter is used beyond this range, it will result in unnormal performance or even permanent damage of the meter.

EV/DV meter's storage range is from -40℃ to 85℃.

2. Humidity

EV/DV meter's working humidity is from 0 to 95% non-condencing.

3. Position

EV/DV meter should be installed in dry and dust free environment and avoid heat, radiation and high electrical noise source.

***Installation Steps***

Normally, the meter was installed on the panel of switch board.

1. Firstly, cut a square hole on the panel of the switch gear. The cutting size is as fig 2.3.

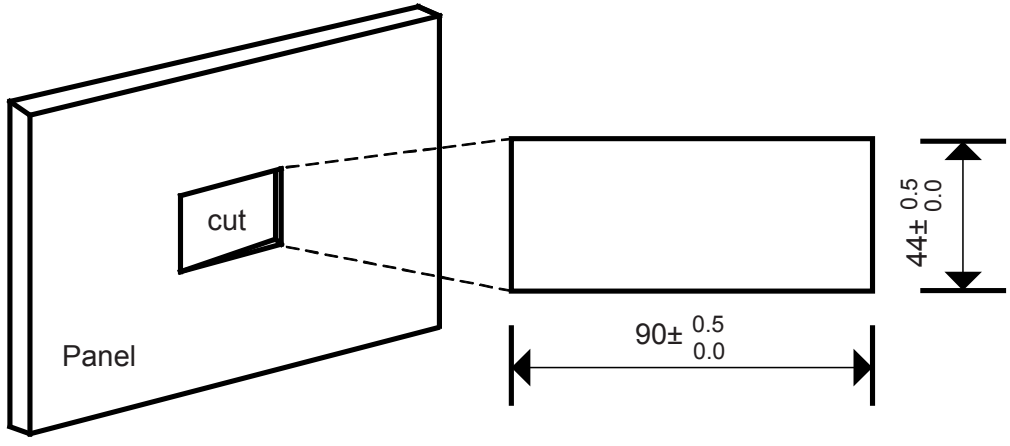



Fig 2.3 Panel Cutting

2. Secondly, remove the clips from the meter and insert the meter into the square hole from the front side.

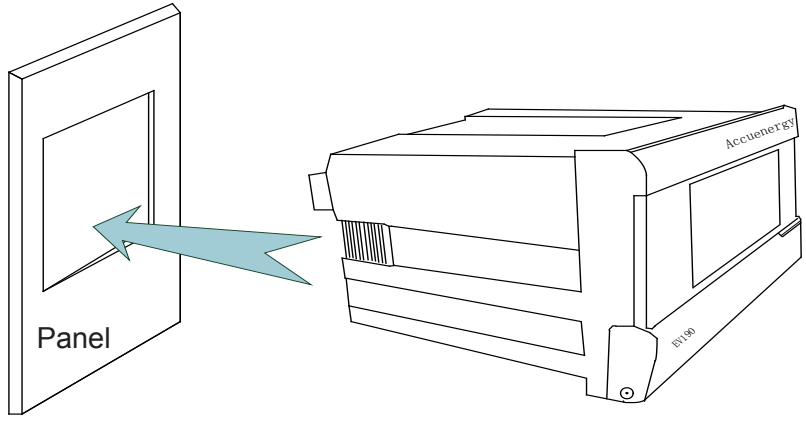



Fig 2.4 Put the meter into square hole

3. Finally, put clips back to the meter from the backside and push the clip tightly so that the meter is fixed on the panel.

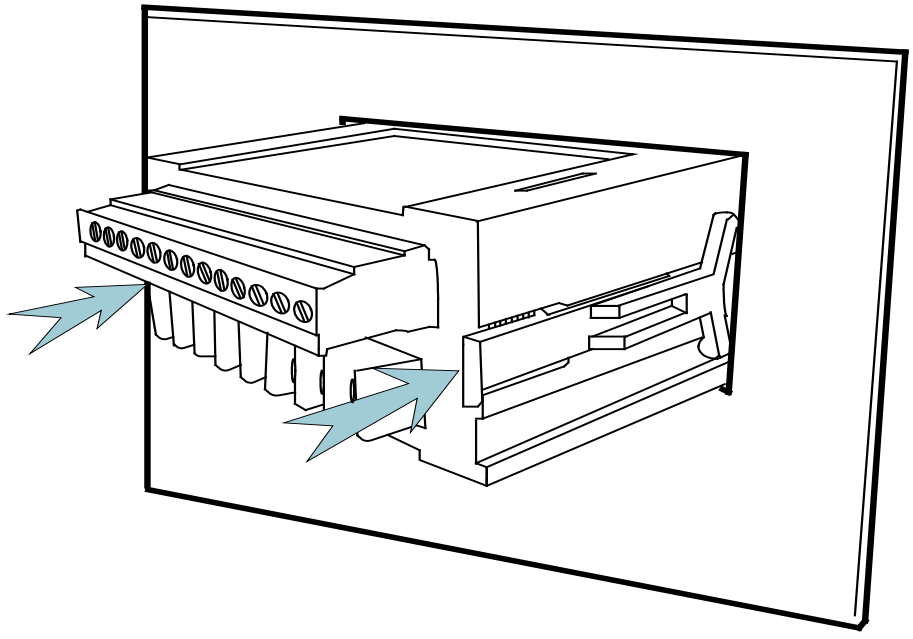
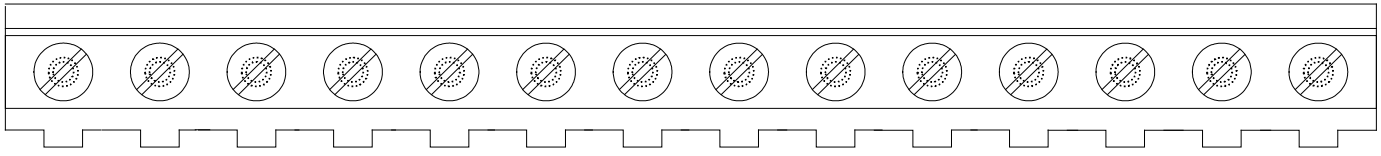


Fig 2.5 Use the clips to fasten the meter on the panel

## 2.3 Wiring

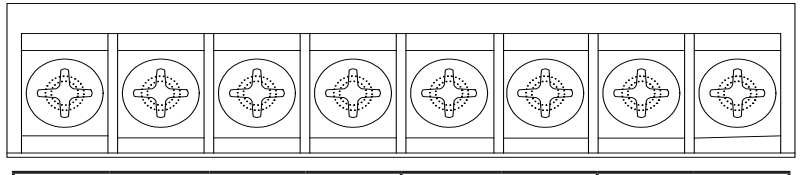
### *Terminal Strips*

There are 2 terminal strips on the back of EV/DV meter.



| DIGITAL INPUTS | | | | | AO | | RELAY OUTPUTS | | | | RS-485 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DI1+ | DI2+ | DI3+ | DI4+ | DIC | AO+ | AO- | R11 | R12 | R21 | R22 | A | B | S |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |

Up terminal Strip: Communication and I/O



| POWER | | | | VOLTAGE INPUT | | CURRENT INPUT | |
|---|---|---|---|---|---|---|---|
| L | N | G | NC | VL | VN | I1 | I2 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

Low terminal Strip: Power, Voltage and Current Input

*Note: NC means No Connection. Certain terminals may not exist if some type of meter is selected.*

Fig 2.6 Terminal Strips

**DANGEROUS**

Only the qualified personnel could do the wire connection work. Make sure the power supply is cut off and all the wires are electroless. Failure to observe it may result in severe injury.

**Note**

Make sure the voltage of power supply is the same as what the meter needed for its auxiliary power.

### *Safety Earth Connection*

Before doing the meter wiring connection, please make sure that the switch Panel has a safety Earth system. Connect the meter safety earth terminal to the switch gear safety earth system. The following safety earth symbol is used in the user 's manual.

### *Auxiliary Power*

The auxiliary power supply of the Acuvim meter is 85~264Vac (50/60Hz) or 100~280Vdc. Typical power consumption of the meter is less than 2W. A regulator or a UPS should be used when the power supply undulates too much. The terminals for the auxiliary power supply are 1, 2 and 3 (L, N, G). A fuse (typical 1A/250Vac) should be used in auxiliary power supply loop. No.3 terminal must be connected to the safety earth system of switchgear. An isolated transformer or EMI filter should be used in the auxiliary power supply loop if there is power quality problem in the power supply. Typical Wiring of Auxiliary Power Supply is as Fig 2.7.

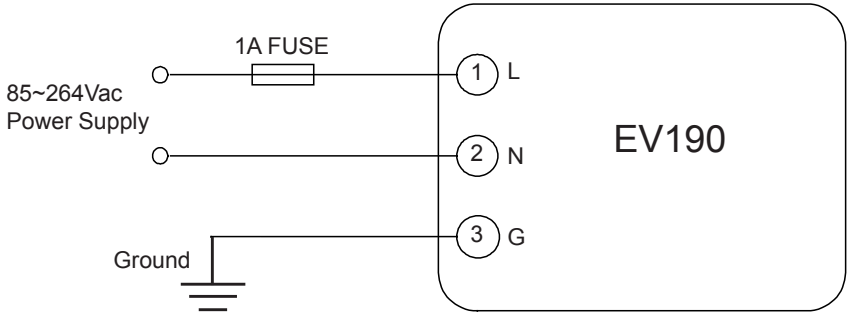



Fig 2.7 Wiring of Power Supply

The Best choice the wire of power supply could be AWG16~22 or 0.6~1.5mm$^2$.

### *Voltage Input*

**Note**

The secondary of PT can not be shorted , otherwise it may cause the severe damage of the instrument .

Two Voltage Input options of EV/DV meter are 100Vac and 400Vac.

100Vac option is suitable for low voltage system that less than 120Vac or high or medium voltage system that the secondary of PT is 100Vac.

400Vac option is suitable for low voltage system that less than 480Vac. The voltage input could be directly connected to the terminal of EV/DV without the use of PT.

A fuse (typical 1A/250Vac) should be used in voltage input loop.

The wire number of voltage input could be AWG16~22 or 0.6~1.5mm$^2$.

***Current Input***

**Note**

The CT loop should not be open circuit in any simultaneously when the power is on. There should not be any fuse or switch in the CT loop and one end of the CT loop should be connected to the ground.

In a practical engineering application, CTs should be installed in the loop of measuring. Normally the secondary of CT is 5A. 1A is possible in the ordering option. A CT of accuracy over 0.5% (rating over 3VA) is recommended and it will influence the measuring accuracy. The wire between CT and meter should be as shorter as possible. The length of the wire may increase the error of the measurement.

The wire number of current input could be AWG15~16 or 1.5~2.5mm$^2$.

***Wiring of Current Input***

Before Wiring, Please Make sure the voltage and current input of the meter corresponding to power system measured.

Single Phase Current Input Wiring Diagram. Fig 2.8 (For EV162, DV102)

Single Phase Voltage Input Wiring Diagram. Fig 2.9 (For EV161, EV166, DV101, DV106)

Single Phase Voltage and Current Input Wiring Diagram. Fig 2.10(For EV163, EV164, EV165, EV167, EV182, EV184, EV188, EV190)DV103, DV104, DV105, DV107, DV122, DV124, DV128, DV130).

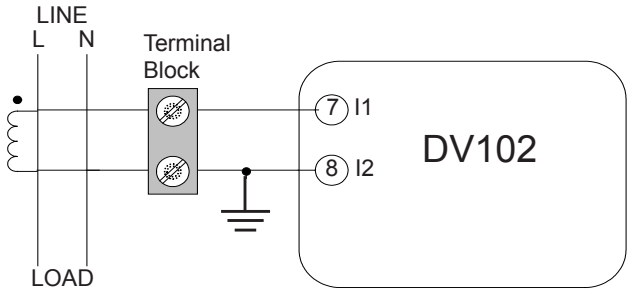



Fig 2.8 Current Input

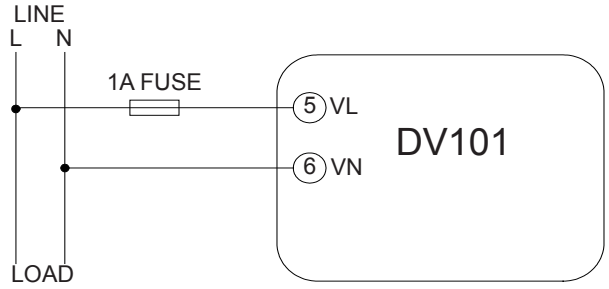



Fig 2.9 Voltage Input

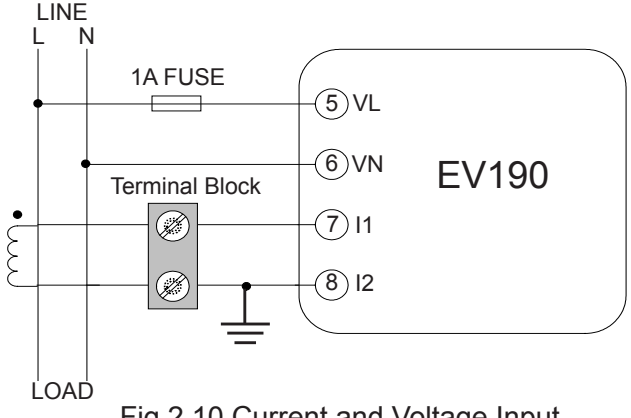



Fig 2.10 Current and Voltage Input

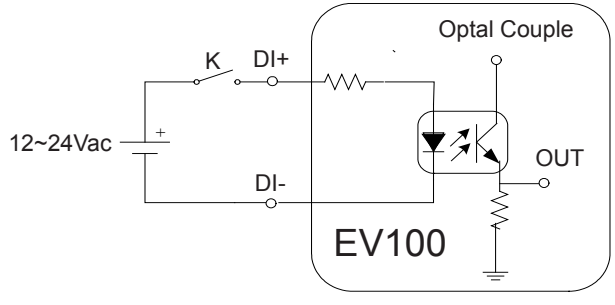



Fig 2.11 Digital Input

***Digital Input***

There is 4 Digital Inputs (Option) which outside power supply is needed in EV Series. The Input terminals are DI1+(9), DI2+(10), DI3+(11), DI4+(12), DIC(13), as in Fig 2.11.

The outside power supply used for Digital Input is from 16Vdc to 30Vdc. If the switch is far from the meter, the voltage of power supply could be higher. The maximum current in the circuit should not over 10mA. The wire number of Digital input could be AWG16~22 or 0.6~1.5mm$^2$.

***Relay Output***

There are two additional relay output for option in the meter. The terminal are R11, R12 (16, 17) and R21, R22 (18, 19). These two relay output are used to remote control electric switch in power system. Relay type is mechanical Form A contact with 3A/250V or 3A/30Vdc. A mediate relay is recommended in the output circuit as in Fig 2.12.

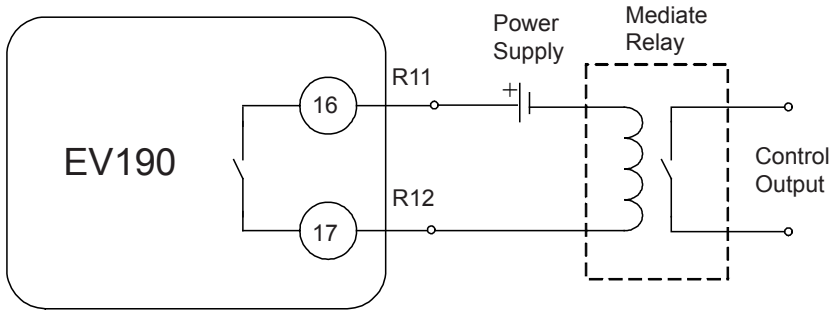



Fig 2.12 Relay Output

There are two relay output modes for selection, one is latching, and the other is momentary. For the latching mode, the relay can be used to output two statues on or off. For the momentary mode, the output of the relay changes from off to on for a period of time Ton and than goes off. Ton can be setting from 50- 3000ms.

The wire of relay output should be chose between AWG22 (0.5mm$^2$)~AWG16 (1.5mm$^2$).

***Alarm Output***

There is an alarm function in EV100 series meter. The alarm will be triggered when a metering parameter is over the limit value and over the setting time limit. The alarm can be related to relay output or LCD back-light flashing, The setting of alarm is as following.

1. Set the relay output mode as alarm. (DO?_MODE=2)
2. Assign metering parameter to alarm. (Refer Table 2.2)
3. Set alarm time limit. (Min time: 1s, Range: 0~255s)
4. Set alarm value limit.
5. Sign of the inequation. (0: parameter<Value limit, 1: parameter>Value limit)
6. Relate to relays. (0: RO1, 1: RO2)

For register of setting parameters please refer to 4.3 of this manual.

Serial number versus alarming parameter is listed in Table 2.2. Number 0 means no parameter is assigned to alarm.

| Number | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Parameter | —— | Hz | U | I | P | Q | S | PF |

Table 2.2 Serial number versus alarming parameter

**Example:**

Alarming parameter: I, Time limit: 15s,

Alarm output relay: RO1, Rating of CT1 of I: 200A,

Value limit: 180A.

The setting of alarm is as following:

1. Set the relay output mode as alarm. DO?_MODE=2

2. The serial number of I is 3 from Table 2.2.

3. CT1=200, the equation converting between real value and register value is:

***Real value=(value in register × CT1 ÷ 5) ÷ 1000***

If real value is 180A, the register value is 4500.

4. Time limit is 15s. The register value is 15.

5. The value is high limit, so the sign of in equation is 1 (great than).

The alarm happens when register value>4500.

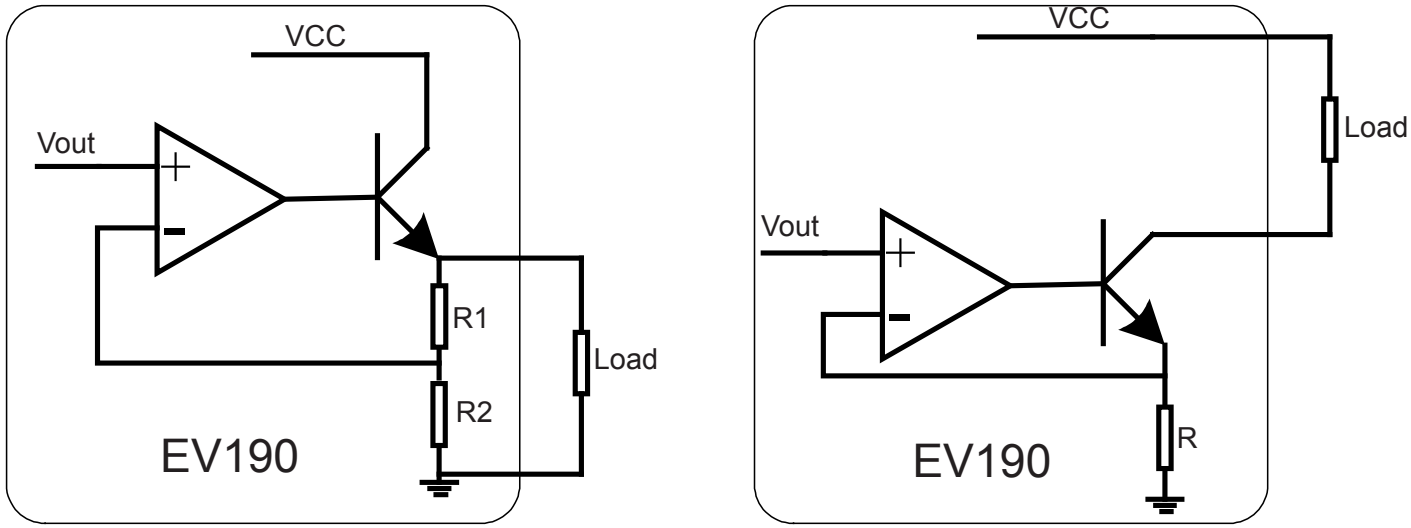
6. The alarm relating relay is RO1, so the RO select 0.

After finish above setting, the alarm will trigger RO1 and back-light flashing when value of I is over 180A and last over 15 seconds.

***Analog Output***

An analog output (Option) is provided in EV/DV Meter. Any one of the seven parameters could be selected as Analog output. Refer to Chapter 3.

Analog Output could be one of the following output, 4~20mA, 0~1mA and 0~5V




Voltage Output Type

Current Output Type

Fig 2.13 Analog Output Diagram

Output Capability:

4~20mA Max Load Resistance 750Ω

0~1mA Max Load Resistance 10KΩ

0~5V Max Output Current 20mA

***Communication***

The communication port and protocol of EV/DV meter are RS485 and Modbus-RTU. The terminals of communication are A, B, and S (20, 21, 22). A is differential signal +, B is differential signal - and S connected to shield of twisted pair cable. Up to 32 devices can be connected on a RS485 bus. Use good quality shielded twisted pair cable, AWG22 (0.5mm$^2$) or larger. The overall length of the RS485 cable connecting all devices can not exceed 1200m (4000ft). EV/DV meter is used as a slave device of master like PC, PLC, data collector or RTU.

The topology of RS485 net can be line, circle and star.

A few points of recommendation for high quality communication are as follows:

- ☞ Good quality shielded twisted pair of cable AWG22 (0.6mm$^2$) or larger is very important.
- ☞ The shield of each segment of the RS485 cable must be connected to the ground at one end only.
- ☞ Make sure the right connection of each point.
- ☞ Avoid T connection at each point.
- ☞ Keep cables away as much as possible from sources of electrical noise.

# Chapter 3 Basic Operation and Setup

## 3.1 Display Panel and Keys

There are one display panel and four keys in the front of the meter. All the display segments are illustrated in fig 3.1.

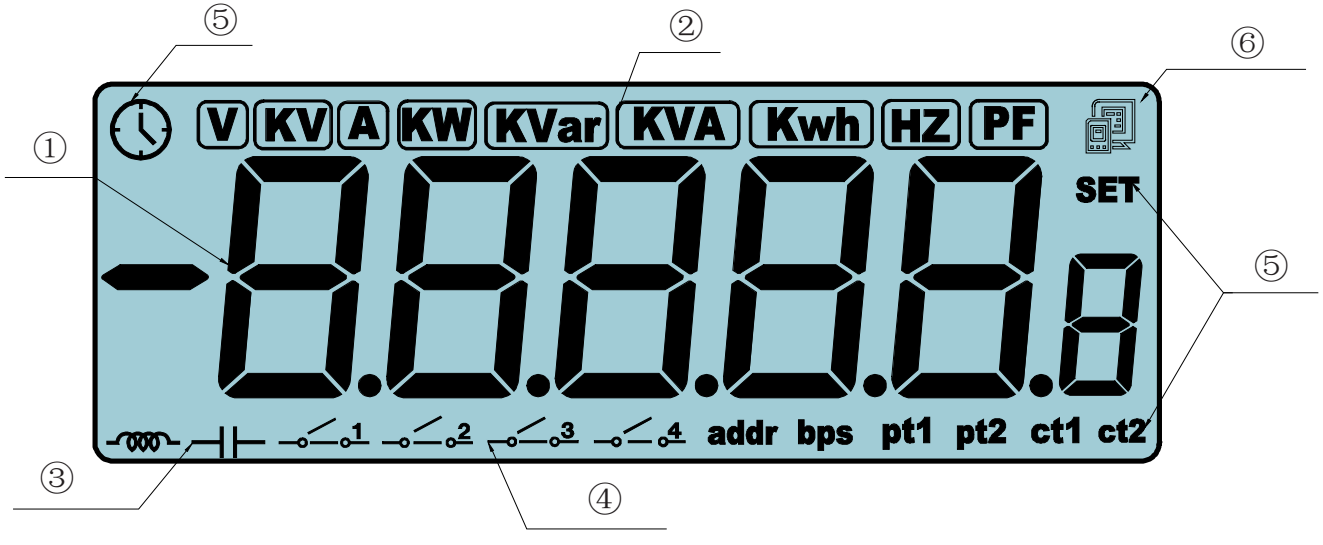



Fig 3.1 All Display Segments

| Number | Display | Description |
|---|---|---|
| ① | Data and Parameters | Display metering data in metering mode.<br>Display parameters in setting mode. |
| ② | Unit Label | Indicating Metering data unit. V and KV for Voltage, A for Current, KW for Power, KVar for Reactive Power, KVA for Apparent Power, KWH for Energy, PF for Power Factor, Hz for Frequency. |
| ③ | Load Nature | " ⊣⊢ " : Capacitive Load, " ∿ " : Inductive Load |
| ④ | Digital Input | Indicator No.1 to No.4 switch indicate statues of DI1 to DI4 |
| ⑤ | Parameter Label | "SET" label is on when the meter is in the setting mode. One of the following label is also on. Addr for communication address, bps for Communication Rate (Bit per Second), pt1 for primary voltage, pt2 for secondary voltage, ct1 for primary current, ct2 for secondary current and " 🕓 " for time of back light； |
| ⑥ | Communication state | When " 🖳 " is on, it indicates that there is communication information between meter and master instrument. |

Table 3.1 Display Panel Description

There are four delicacy keys labelled as "◁▷ ", E, P and V/A. Use these four keys to read metering data and do parameter setting.

All the description in this manual is about EV190 which is a full function single phase power meter. For other EV/DV100 series meters, please refer to the corresponding function or description.

## 3.2 Meter Data Reading

Normally, EV/DV meter display the metering data, such as voltage, current, power etc. To read the metering data simply press the keys "P", "E" and "V/A".

Press "V/A" key to read voltage, current and frequency.

Fig 3.2 Voltage Display

The first screen: Display Voltage, U=220.3V, Inductive load, Communication Port Busy, DI1, DI2, DI3 and DI4 Open.

Press "V/A", go to the second screen.

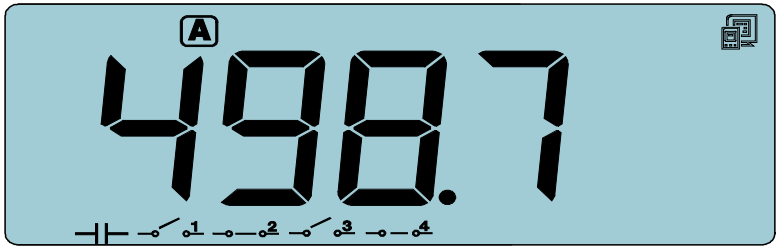



Fig 3.3 Current Display

The second screen: Display current. As in fig 3.3, I=498.7A.

Press “V/A”, go to the third screen.

Fig 3.4 Frequency Display

The third screen: Display frequency. As in Fig 3.4, F=50.00Hz.

Press “V/A” again, go back to the first screen.

Press P key, display power related metering data.

Fig 3.5 Power Display

First screen: Display Power.

In Fig 3.5, P=350.6KW, inductive Load, communication port busy, DI1 DI3 close and DI2 DI3 open.

Press “P”, go to the second screen.

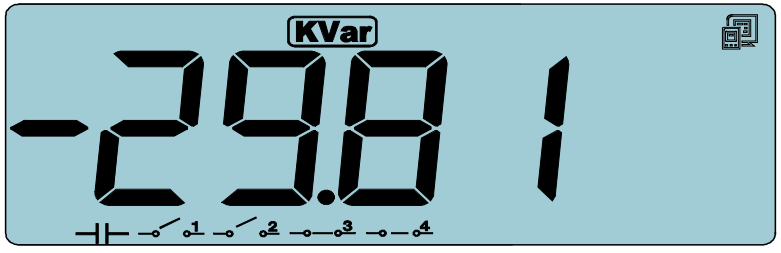



Fig 3.8 Power Factor Display

The second screen: Display reactive power.

In Fig 3.6, Q=-29.81KW, capacitive load.

Press “P”, go to the third screen.

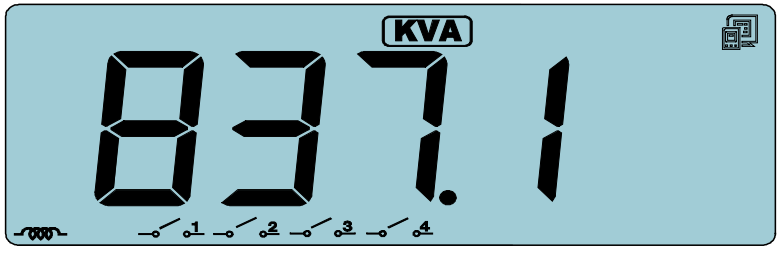



Fig 3.6 Reactive Power Display

The third screen: Apparent Power Display.

In fig 3.7, S=837.1KVA

Press “P”, go to the forth screen.

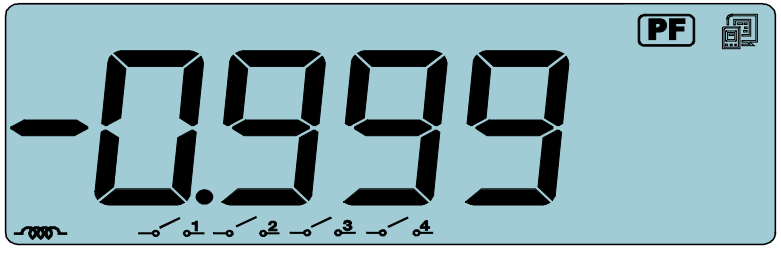



Fig 3.7 Apparent Power Display

The forth screen: Display Power Factor.

In fig 3.8, PF=-0.999.

Press “P”, go back to the first screen.

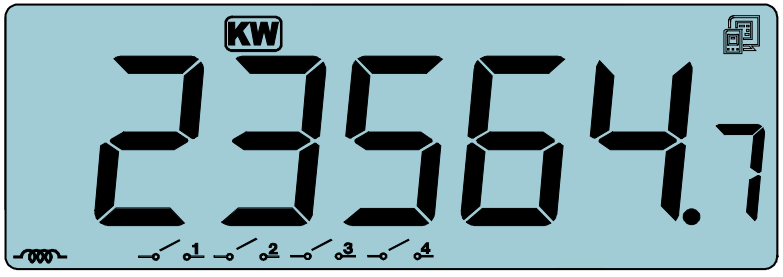



Fig 3.9 Display Power with Six Digits

When the value of P, Q and S is great then 9999, the display will change to six digits mode. For example,

in fig 3.9, P=23564.7 KW.

Press E, display energy.

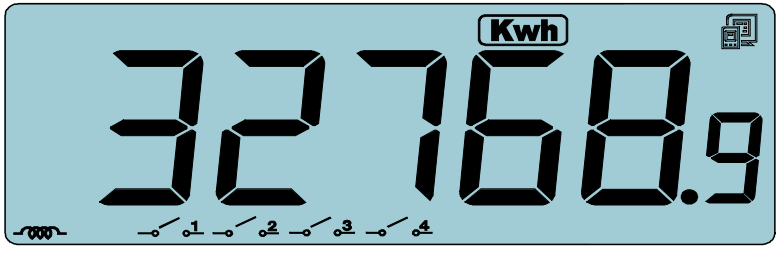



Fig 3.10 Energy Display

In fig 3.10, E=32768.9 Kwh. Energy display range is from 0 to 999999Kwh. Over 106 Kwh, energy register will turn to 0.

## 3.3 Parameter Setting

In metering mode, Press “ ◁▷ ” and V/A to go to the parameter setting mode.

Note

The setting should be done by the professional personnel after he has read this user's manual and understand the application situation.

Press "◁▷" to move cursor from left to right. The digit will flashing when the cursor move to it.

Press E to increase 1 once a time. Press P to decrease 1 once a time. Press V/A to confirm the former key input and press "◁▷" again go to next screen. In any screen, press "◁▷" and V/A at the same time to exit the parameter setting mode.

Before going into the parameter setting, the address of the meter will display 3 seconds. Then go to the parameter setting mode. There is pass word input screen to protect the parameter setting mode.

Four digits Access code integer is used between 0000 and 9999. The default access code is 0000. Each time before going to the parameter setting mode, correct access code must be entered.

Fig 3.11 Access Code Input

Asking for access code as in Fig 3.11.

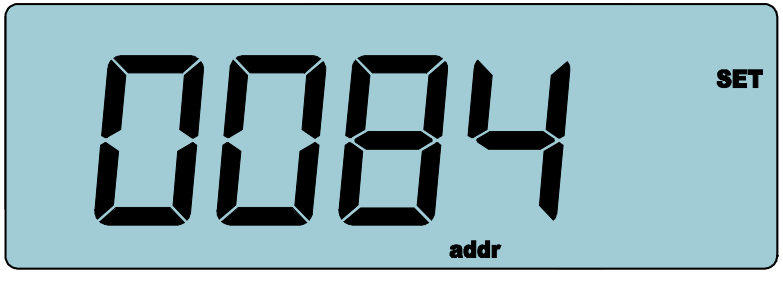



Fig 3.12 Communication Address Setting

First Screen: Meter's Communication Address setting. The address can be any integer between 1 and 254. As in fig 3.12, the communication address is 84. If address changing needed, press "◁▷" to move cursor, press P for increasing and press E for decreasing. After the expected address is set, press V/A to go to the next setting screen. Press V/A to go to the next screen if there is no need to change the address.

**Two or more meters should not be set the same address in the same communication line according to the Modbus-RTU protocol.**

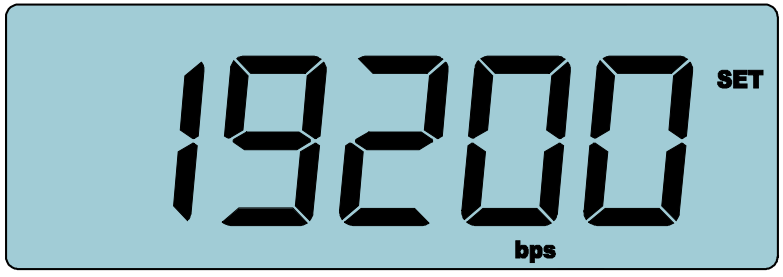



Fig 3.13 Baud Rate Setting

The second screen: Baud rate setting page.

Modbus-RTU 8 data bit, no parity, 1 start bit and 1 stop bit. Baud rate could be one of the five value, 1200, 2400, 4800, 9600, 19200bps. In fig 3.13 baud rate is 19200bps. Just press E key to select baud rate. Press V/A to go to next screen. Only one baud rate should be selected on the same communication line.

Fig 3.14 PT1 Setting

The third screen: PT primary rating voltage PT1 setting page.

PT1 value is an integer from 100 to 500,000.

The unit is volt.

In fig 3.14, PT1=100000V, Use P, E and keys to change PT1 value. Press "◁▷" V/A key for acknowledgment and going to the next setting page.

Fig 3.15 PT2 Setting

Fig 3.16 CT1 Setting

Fig 3.17 CT2 Setting

The forth screen: PT secondary rating voltage PT2 setting page. PT2 value is an integer from 100 to 400. The unit is volt. As in fig 3.15, PT2=400V, press P, E and "◁▷" to change the value. Press V/A key for acknowledgment and going to the next setting page.

**Note: If there is no PT on the voltage input side, the PT1 and PT2 should be the same and equal to the input rating voltage.**

The fifth screen: CT primary rating current CT1 setting page CT1 value is an integer from 5 to 9999. The unit is Amp. As in fig 3.16, CT1=5000A, pressing P, E and "◁▷" keys to change the value. Press V/A key for acknowledgment and going to the next setting page.

The sixth screen: The defult value of CT2 is 5 A. If the meter is 1A option, CT2 should be 1A.

图3.18 模拟变送对象设定页

The seventh screen: Analog output setting page. One metering value can be selected as analog output. The number 0 to 6 is corresponded to frequency, voltage, current, power, reactive power, apparent power and power factor. There is not this setting page in single function meter.

There are three output modes, 4~20mA, 0~1mA and 0~5V in EV/DV series, which is chosed when ordering. The relation between the output mode and metering data is as Fig3.19(a), (b), (c).

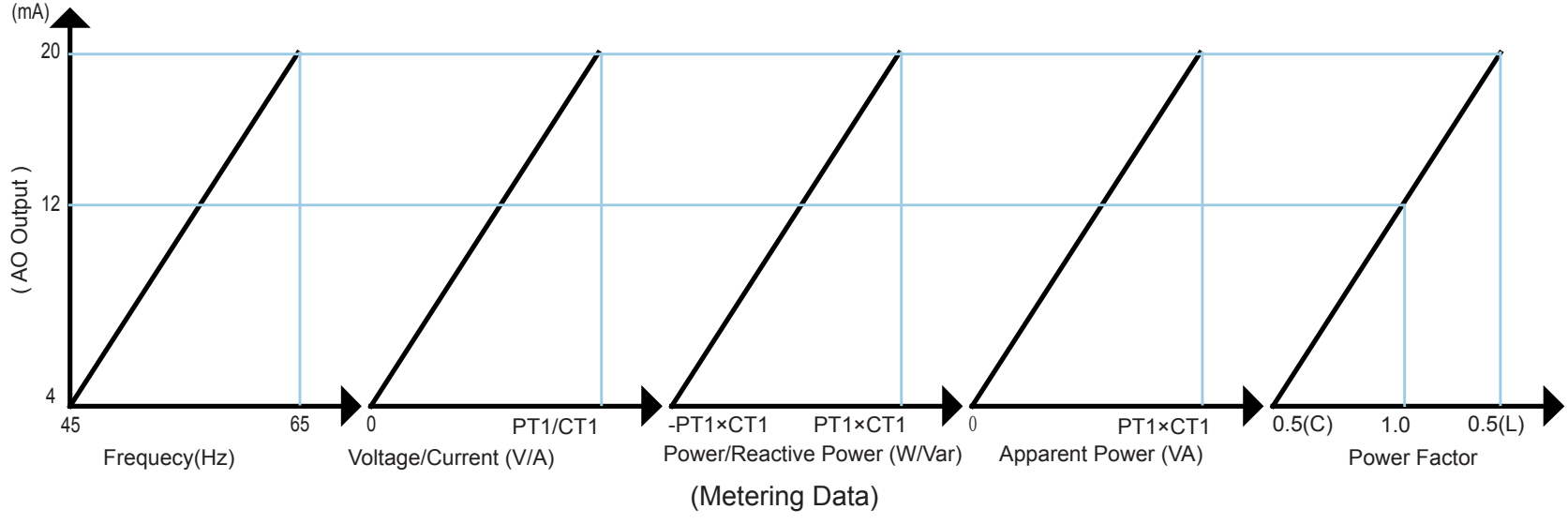



Fig 3.19(a) Anolog Output (4~20mA) VS metering Data

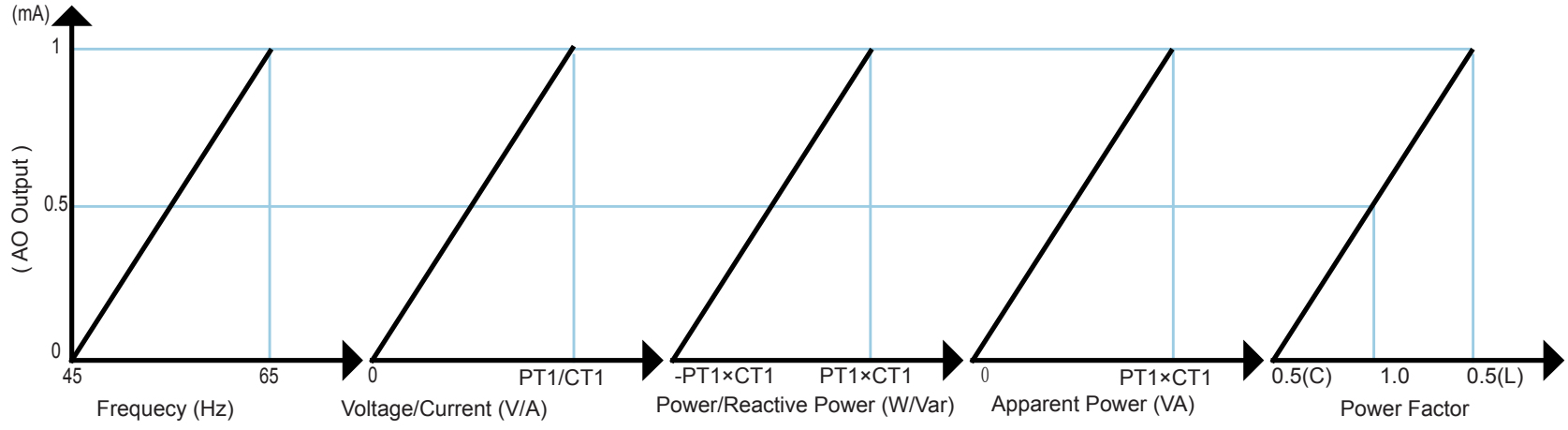



Fig 3.19 (b) Analog Output (0~1mA) VS Metering Data

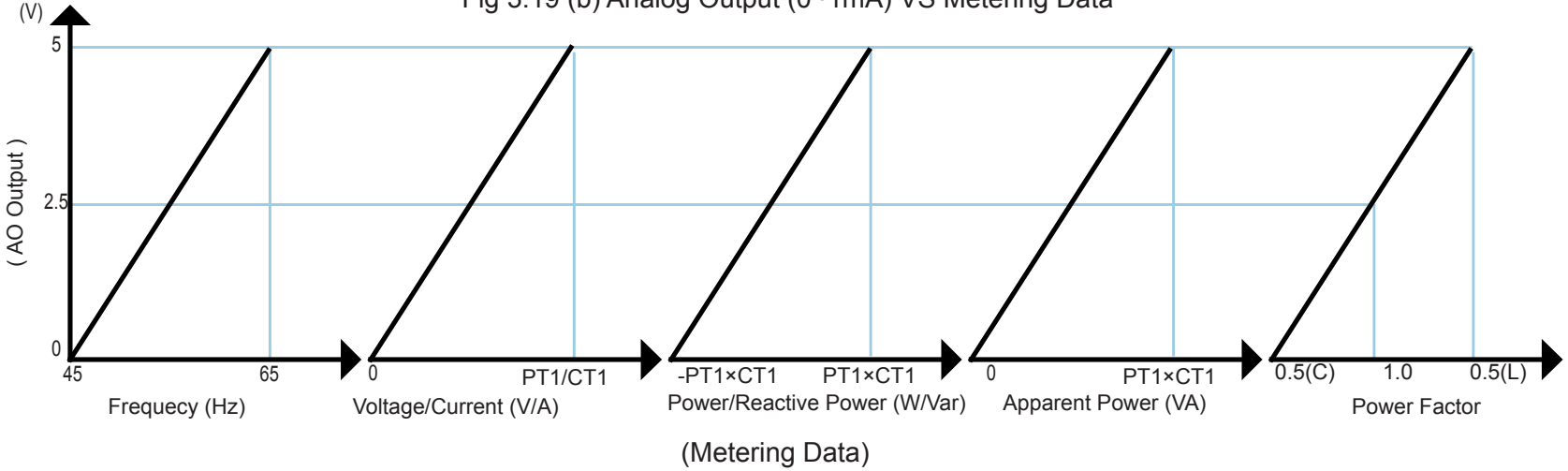



Fig 3.19 (c) Analog Output (0~5V) VS Metering Data

Fig 3.20 Back light “on” time

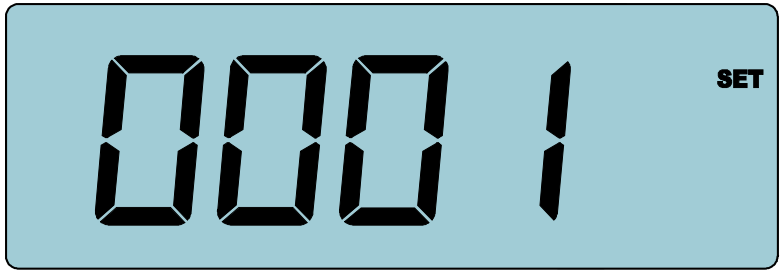



Fig 3.21 Access Code setting

The eighth screen: Display back light “on” time setting page. The backlight will go to “off ” for the purpose of energy saving and component duration if the keys do not be touched for a period time. The “on” time can be set from 0 to 120 Minute. The back light will always be “on” if the setting value is 0.

As in fig 3.20, the setting time of the back light is 5 minutes. The back light will automatically go to “off” if there is no touch on the keys in 5 minutes.

The ninth screen: Access code setting page.

This is the last screen of the setting page. The access code can be changed in this setting page. It is important to remember the new access code after the setting.

As in fig 3.21, the access code is 0001. Press the V/A key, let the access code be stored in meter and go back to the first setting page. All the setting has been finished. Press “◁▷” and V/A keys, exit the setting mode.

The setting page may be different depending on the meter type. Please confirm the meter type before doing the parameter setting.

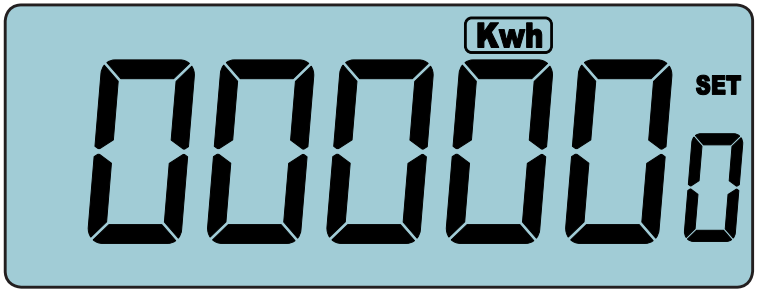



Fig 3-22 Real energy

Take DV130 for example. The seventh page is real energy presetting page, Use "◁▷" , E and P key to preset the value of energy. As in Fig 3-22, the energy value is 0 Kwh, Press V/A to acknowledge and go to the next setting page.

# Chapter 4 Communication



## 4.1 Introduction of Modbus Protocol

The ModbusTM RTU protocol is used for communication in EV/DV meter. The data format and error check method are defined in Modbus protocol. The half duplex query and respond mode is adopted in Modbus protocol. There is only one master device in the communication net. The others are slave devices, waiting for the query of the master.

Only master device can communicate with slave device. The slave devices can not communicate with each other. They just response the query of master device.

***1. Transmission mode***

The mode of transmission defines the data structure within a frame and the rules used to transmit data. The mode is defined in the following which is compatible with Modbus RTU Mode*.

| | |
|---|---|
| Coding System | 8 bit |
| Start bit | 1 bit |
| Data bit | 8 bit |

| | |
|---|---|
| Parity | None |
| Stop bit | 1 |
| Error Checking | CRC |

***2. Protocol***

Framing

| Address | Function | Data | Check |
|---|---|---|---|
| 8-Bits | 8-Bits | N×8-Bits | 16-Bits |

Table 4.1 Data Framing

**Address Field**

The address field of a message frame contains eight bits. Valid slave device addresses are in the range of 0~255 decimal. A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.

**Function Field**

The function code field of a message frame contains eight bits. Valid codes are in the range of 1~255 decimal. When a message is sent from a master to a slave device the function code field tells the slave what kind of action to perform.

| Code | Meaning | Action |
|---|---|---|
| 01 | Read Relay output | Status Obtain current status of Relay Output |
| 02 | Read Digital Input | Status Obtain current status of Digital Input |
| 03 | Read Registers | Obtain Current binary value in one or more registers |
| 05 | Control Relay Output | Force Relay to a state of on or off |
| 16 | Preset Multiple-Registers | Place specific binary values into a series of consecutive Multiple-Registers |

Fig 4.2 Function Code

**Data Field**

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal. The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.

**Check Field**

Check field is used in master and slave device to find errors in the data transmitting process. There may be some error happening to a group of data when they are transmit from one device to the other due to noise or other interference. The check field guarantee the device does not respond error

massages so as to improve system safety and efficiency. CRC16 error check method is adopted in Modbus Protocol.

### *3. Error Check Method*

Messages include an error's checking field that is based on a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message. The CRC field is two bytes, containing a 16 bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message.

The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error will be report. The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC. During generation of the CRC, each 8-bit character is exclusive ORed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value. If

the LSB was a 0, no exclusive OR takes place. This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8-bit byte is exclusive ORed with the register current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the bytes of the message have been applied, is the CRC value. When the CRC is appended to the message, the low-order byte is appended first, followed by the high-order byte.

## 4.2 Format of Communication

All the examples in this chapter are following the format of Table 4.3. (All data is express in Hex).

| Addr | Fun | Data start reg hi | Data start reg lo | Data #of regs hi | Data #of regs lo | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|---|---|
| 11H | 03H | 01H | 00H | 00H | 08H | 47H | 60H |

Table 4.3 Protocol Format

In table4.3, the meaning of each abbreviated word is,

Addr: address of slave device

Fun: function code

Data start reg hi: start register address high byte

Data start reg lo: start register address low byte

Data #of reg hi: number of register high byte

Data #of reg lo: number of register low byte

CRC16 Hi: CRC high byte

CRC16 Lo: CRC low byte

***1.Read Status of Relay***

Function Code 01

Query

This function code is used to read status of Relay in the meter.

1=On 0=Off

There are 2 Relays in the meter. The Address of each Relay is Relay1=0000H and Relay2=0001H.

The following query is to read Relay Status of the meter Number 17.

| Addr | Fun | Data start reg hi | Data start reg lo | Data #of regs hi | Data #of regs lo | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|---|---|
| 11H | 01H | 00H | 00H | 00H | 02H | BFH | 5BH |

Table 4.4 Relay status query message

Response

The meter response includes the meter address, function code, quantity of data byte, the data, and error checking. An example response to read the status of Relay1 and Relay2 is shown as Table4.5. The status of Relay1 and Relay2 is responding to the last 2 bit of the data. Relay1: bit0 Relay2: bit1.

| Addr | Fun | Byte count | Data | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|
| 11H | 01H | 01H | 02H | D4H | 89H |

Table 4.5 Relay status responds

The content of the data is,

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

MSB LSB

（Relay 1 = OFF , Relay 2=ON）

***2. Read the Status of DI***

Function Code 02

Query

1=On 0=Off

There are 4 DIs in the meter. The Address of each DI is DI1=0000H, DI2=0001H, DI3=0002H and DI4=0003H. The following query is to read the 4 DI Status of the meter Number 17.

| Addr | Fun | Data start reg hi | Data start reg lo | DI num hi | DI num lo | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|---|---|
| 11H | 02H | 00H | 00H | 00H | 04H | 7BH | 59H |

Table4.6 Read 4 DIs Query Message

Response

The Acuvim response includes the Acuvim address, function code, quantity of data characters, the data characters, and error checking. An example response to read the status of 4 DIs is shown as Table 4.7. The status of each is responding to the last 4 bit of the data. DI1: bit0 DI2: bit1 DI3: bit2 DI4: bit3.

| Addr | Fun | Byte count | Data | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|
| 11H | 02H | 01H | 03H | E5H | 49H |

Table 4.7 Read Status of DI

Data

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

MSB LSB

### *3 Read Data (Function Code 03)*

Query

This function allows the master to obtain the measurement results of the meter. Table 4.8 is an example to read the 3 measured data (F, V and I) from slave device number 17, the data address of F is 0000H, V1 is 0001H and V2 is 0002H.

| Addr | Fun | Data start reg hi | Data start reg lo | Data #of regs hi | Data #of regs lo | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|---|---|
| 11H | 03H | 00H | 00H | 00H | 03H | 07H | 5BH |

Table 4.8 Read F, V, I Query Message

Response

The meter response includes the meter address, function code, quantity of data byte, data, and error checking. An example response to read F, V and I (F=1388H (50.00Hz), V=03E7H (99.9V), I=1386H (4.998A) is shown as Table 4.9.

| Addr | Fun | Byte count | Data1 hi | Data1 lo | Data2 hi | Data2 lo | Data3 hi | Data3 lo | CRC16 hi | CRC16 lo |
|---|---|---|---|---|---|---|---|---|---|---|
| 11H | 03H | 06H | 13H | 88H | 03H | E7H | 13H | 86H | 32H | E8H |

Table 4.9 Read F, V and I Message

### *4. Control Relay(Function Code 05)*

Query

This message forces a single Relay either on or off. Any Relay that exists within the meter can beforced to be either status (on or off). The address of Relays starts at 0000H (Relay1=0000H Relay2=0001H). The data value FF00H will set the Relay on and the value 0000H will turn it off; all other values are illegal and will not affect that relay.

The example below is a request to the meter number 17 to turn on Relay1.

| Addr | Fun | DO addr hi | DO addr lo | Value hi | Value lo | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|---|---|
| 11 | 05H | 00H | 00H | FFH | 00H | 8EH | AAH |

Table 4.10 Control Relay Query Message

Response

The normal response to the command request is to retransmit the message as received after the Relay status has been altered.

| Addr | Fun | DO addr hi | DO addr lo | Value hi | Value lo | CRC16 Hi | CRC16 Lo |
|---|---|---|---|---|---|---|---|
| 11H | 05H | 00H | 00H | FFH | 00H | 8EH | AAH |

Table 4.11 Control Relay Response Message

### *5. Preset / Reset Multi-Register(Function Code 16)*

Query

Function 16 allows the user to modify the contents of a Multi-Register. Any Register that exists within the meter can have its contents changed by this message. The example below is a request to an meter number 17 to Preset E (17807.7KWH), while its Hex Value 0002B79DH. E data address is 0109H and 010AH. E register is 32bit or 4 byte.

| Addr | Fun | Data start reg hi | Data start reg lo | Data #of reg hi | Data #of reg lo | Byte count |
|---|---|---|---|---|---|---|
| 11H | 10H | 01H | 09H | 00H | 02H | 04H |

| Value hi | Value lo | Value hi | Value lo | CRC16 hi | CRC16 lo |
|---|---|---|---|---|---|
| 00H | 02H | B7H | 9DH | 7DH | 0CH |

Table 4.12 Control Relay Response Message

Response

The normal response to a preset Multi-Register request includes the slave address, function code, data start register, the number of registers and error checking.

| Addr | Fun | Data start reg hi | Data start reg lo | Data #of reg hi | Data #of reg lo | CRC16 hi | CRC16 lo |
|---|---|---|---|---|---|---|---|
| 11H | 10H | 01H | 09H | 00H | 02H | 92H | A6H |

Table 4.13 Preset Multi-Registers Response Message

## 4.3 Address Table

Metering data is stored in these register area. Use Modbus 03 function code to read metering data.

| Address | Parameter | Range | Object Type | Type of Access |
|---|---|---|---|---|
| 0000H | Frequency F | 0 ~ 6500 | Word | R |
| 0001H | Voltage V | 0 ~ 65535 | Word | R |
| 0002H | Current I | 0 ~ 65535 | Word | R |
| 0003H | Power P | -32768 ~ 32767 | Integer | R |
| 0004H | Reactive Power Q | -32768 ~ 32767 | Integer | R |
| 0005H | Apparent Power S | 0 ~ 65535 | Word | R |
| 0006H | Power Factor PF | -1000~ 1000 | Integer | R |
| 0007H | Load Nature RT | 76(L)/67(C)/82(R) | Word | R |
| 0008H | AO Output | 0~65535 | Word | R |
| 0109H<br>010AH | Energy E | 0~9999999 | Dword | R |

Table 4.14 Metering data address table

The Relationship between numerical value in register of Acuvim and the real physical value is as following table. (Rx is the numerical value in register of the meter)

| Parameter | Relationship | Unit |
|---|---|---|
| Frequency F | F=Rx/100 | (Hz) |
| Voltage V | U=Rx(PT1/PT2)/10 | (V) |
| Current I | I=Rx(CT1/5)/1000 | (A) |
| Power P | P=Rx(PT1/PT2)(CT1/5)/10 | (W) |
| Reactive Power Q | Q=Rx(PT1/PT2)(CT1/5)/10 | (Var) |
| Apparent Power S | S=Rx(PT1/PT2)(CT1/5)/10 | (VA) |
| Power Factor PF | PF=Rx/1000 | —— |
| Load Nature RT | ASCII: L、C、R<br>52H:R 43H:C 4CH:L | —— |
| Energy Kwh | Kwh=Rx/10 | Kwh |

Table 4.15 Measuring data convert table

***Parameter Setting***

Function code: 03 for Reading, 16 for Presetting

| Address | Parameter | Type of access | Range | Object type |
|---|---|---|---|---|
| 0101H | Access Code | R/W | 0~9999 | Word |
| 0102H | Communication Address | R/W | 1~254 | Word |
| 0103H | Baud Rate | R/W | 0~4 | Word |
| 0104H | P T1 Lo | R/W | 100~500000 | Dword |
| 0105H | PT1 Hi | | | |
| 0106H | PT2 | R/W | 100~400 | Word |
| 0107H | CT1 | R/W | 5(1)~9999 | Word |
| 0108H | CT2 | R/W | 5(1) | Word |
| 010BH | Relay1 work Mode | R/W | 0-Latch, 1-Momentary, 2-Alarm | Word |
| 010CH | Relay1 pulse width | R/W | 50~3000 | Word |
| 010DH | Relay2 work Mode | R/W | 0-Latch, 1-Momentary, 2-Alarm | Word |
| 010EH | Relay2 pulse width | R/W | 50~3000 | Word |
| 010FH | AO VS Metering Data | R/W | 0~6,0-Frequency,1-Voltage, 2-Current, 3-Power, 4-Reactive Power, 5-Apparent Power, 6-Power Factor | Word |

Table 4.16 System parameter address

| Address | Parameter | Type of access | Range | Object type |
|---|---|---|---|---|
| 0110H | LCD Back light Time | R/W | 0~120 (Min) | Word |
| 0111H | Alarm object select | R/W | 0~7 | Word |
| 0112H | Time limited setting | R/W | 0~255 | Word |
| 0113H | Alarm parameter value | R/W | -30000~30000 | Integer |
| 0114H | Inequation Sign | R/W | 0:< 1:> | Word |
| 0115H | Alarm relate RO | R/W | 0:RO1 1:RO2 | Word |

Table 4.16 System parameter address

***Digital Iput(DI) Status:***

Function code: 02 for Reading

| Address | Parameter | Range | Object type | Type of acess |
|---|---|---|---|---|
| 0000H | DI1 | 1=ON, 0=OFF | Bit | R |
| 0001H | DI2 | 1=ON, 0=OFF | Bit | R |
| 0002H | DI3 | 1=ON, 0=OFF | Bit | R |
| 0003H | DI4 | 1=ON, 0=OFF | Bit | R |

Table 4.17 Digital Input (DI) Address

***Relay Statue and Control***

Function code: 01 for Reading, 05 for Controlling.

| Address | Parameter | Range | Object type | Type of access |
|---|---|---|---|---|
| 0000H | DO1 | 1=ON, 0=OFF | Bit | R/W |
| 0001H | DO2 | 1=ON, 0=OFF | Bit | R/W |

Table 4.18 Relay Address

Note:

1. Object type: Bit - binary bit, word-unsigned integer of 16 bit, Integer - Sign integer of 16 bit, Dword -unsigned integer of 32 bit.

2. Type of Access: R - Read only, Digital input Relay statue and Data are read by using function code 02, 01 and 03 respectively. R/W-Read and Write, Data is written by using function code 16 and control command is written by using function code 05. Writing to read only field is forbidden.

3. Energy data is represented in 32 bit. Both high 16 bit and low 16 bit have successive address alone. The high 16 bit data should be multiplied by 65536 and plus low 16 bit data to get the energy data in master software. The unit is 0.1kwh or 0.1kvarh. It will be clear to zero and start again when energy data accumulate 1 x 106kwh(kvarh). The energy register can be cleared or preset through communication.

# Appendix

## Appendix A Technical Data and Specifications

### Input Ratings

| *Voltage Input* | | |
|---|---|---|
| Voltage Rating | -100V Option | 100Vac 20% Over Range |
| | -400V Option | 400Vac 20% Over Range |
| Frequency Range | | 45 to 65Hz |
| Overload 2 times for continue | | 2500Vac for 1 Sec (None recurrence) |
| Voltage Range Through PT | | 500KV highest at primary side |
| PT Burden | | <0.2VA |
| Measuring | | True-Rms |

| *Current Input* | |
|---|---|
| Current Rating | 5Amp, 20% Over Range<br>Ordering on Special Rating |
| Current Range Through CT | 10000A at primary side |
| Over Load | 10A Continue, 100A/1sec (None Recurrence) |
| CT Burden | <0.5VA |
| Measuring | True-Rms |

| *Digital Input (DI)* | |
|---|---|
| Optical Isolation Isolate Voltage | 4000Vac rms |
| Input Form | Contact with Power Supply |
| Input Resistance | 2K ohm (typical) |
| Input Voltage Range | 16~30Vdc |
| Close Voltage | > 16Vdc |
| Max Input Current | 20mA |

## Accuracy and Resolution

| *Parameter* | *Accuracy* | *Resolution* |
|---|---|---|
| Voltage | 0.5% | 0.1% |
| Current | 0.5% | 0.02% |
| Power | 1.0% | 0.1% |
| Reactive Power | 1.0% | 0.1% |
| Apparent Power | 1.0% | 0.1% |
| Power Factor | 1.0% | 0.1% |
| Frequency | 0.5% | 0.01Hz |
| Energy | 1.0% | 0.1Kwh |
| Drift with Temp. | <100ppm/ ℃ | |
| Stability 0.1%/Year | 0.1%/Year | |

| ***Relay Output*** | |
|---|---|
| Output Form | Mechanical Contact |
| Contact Resistance | 30m ohm@1A |
| Max Break Voltage | 250Vac, 30Vdc |
| Max Break Current | 3A |
| Max Isolate Voltage | 4000Vac rms |

| ***Analog Output*** | | |
|---|---|---|
| Output Range 4~20mA or 0~1mA or 0~5V | | |
| Resolution 12bit | | |
| Output Capability | 4～20mA | Max Resistance: 500Ω |
| | 0～5V | Max Resistance: 10KΩ |
| | 0～1mA | Max Resistance: 20mA |

| ***Standard*** | |
|---|---|
| Measuring | IEC60687 0.5 ANSI C12.16 Class10<br>IEC61036 class1 IEC61268 class2 |
| Environment | IEC 60068-2 |
| Safety | IEC 61557-2 |
| EMC | IEC61000-4/2-3-4-5-6-8-11 |
| Dimension | DIN43700 |

| ***Suitable Condition*** | |
|---|---|
| Dimensions (mm) | 96 ×48 ×60 (Cut 90 ×44) |
| Protection Level | IP54 (Front), IP20 (Cover) |
| Weight (g) | 400 |
| Temperature | -25℃~70℃ |
| Humidity | 0~95% Non-condensing |
| Power Supply | 85~264Vac or 100V~280Vdc |
| Power | 3W MAX |

# Appendix B Ordering Information

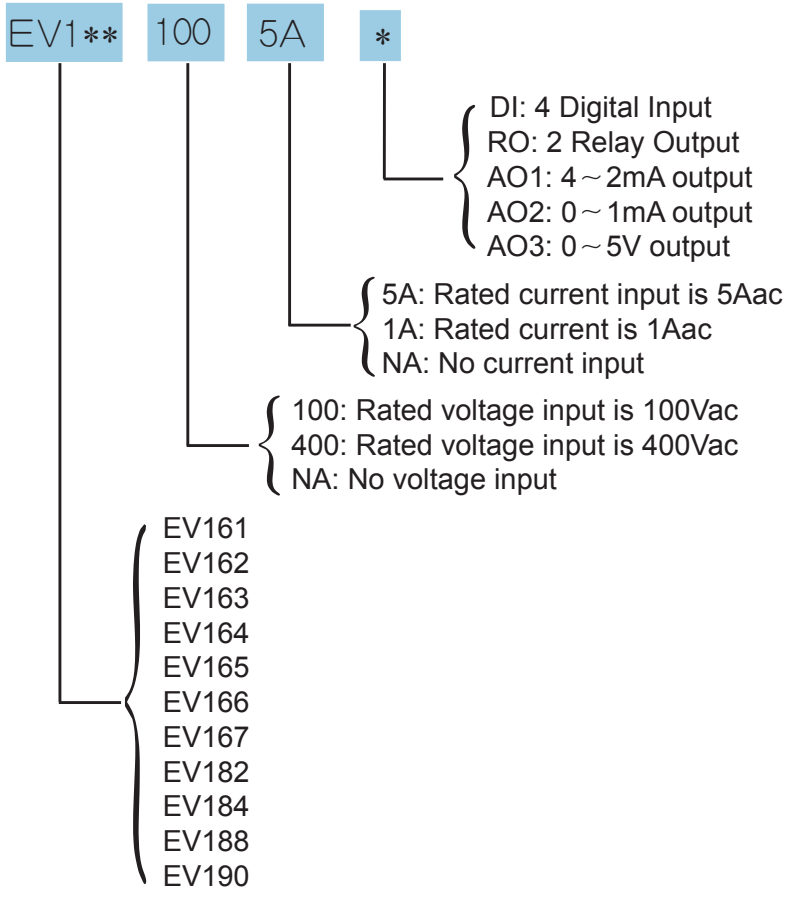



Fig 5.1 EV100 ordering information

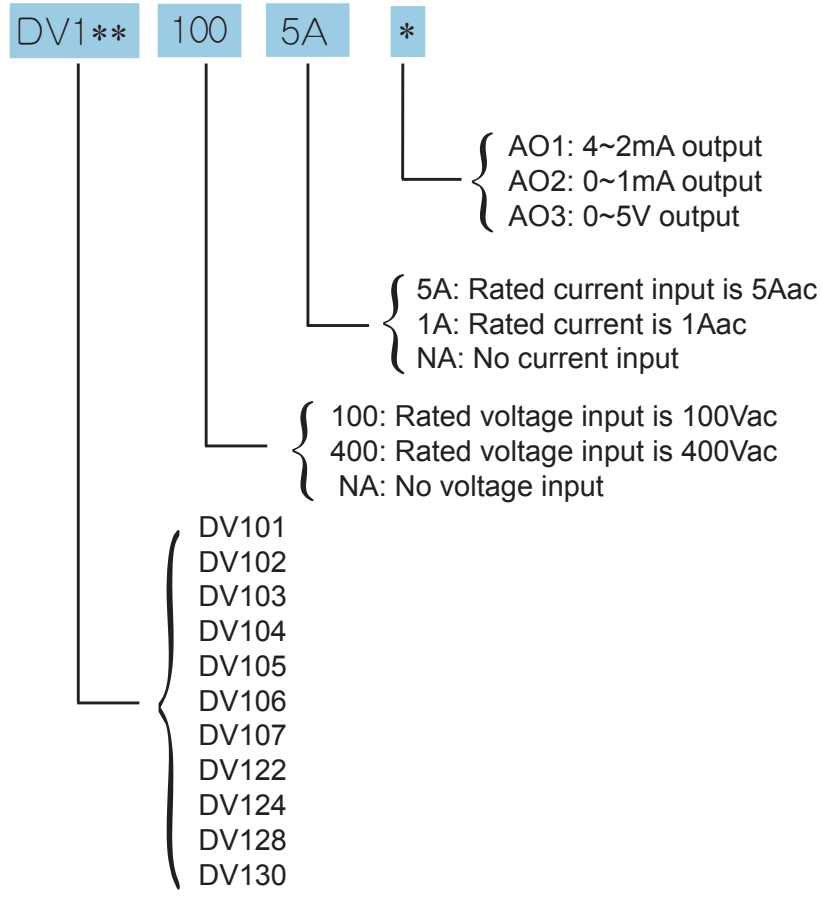



Fig 5.2 DV100ordering information

World Wide Web

http://www.accuenergy.com

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